DOCUMENT RESUME

ED 427 975 SE 062 279

AUTHOR Frederick, Lynda R.; Shaw, Edward L., Jr.
TITLE Examining the Effects of Science Manipulatives on Achievement, Attitudes, and Journal Writing of Elementary Science Students.
PUB DATE 1998-11-04
NOTE 16p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (New Orleans, LA, November 4-6, 1998).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Achievement Gains; *Elementary School Science; Grade 4; *Hands on Science; Intermediate Grades; *Journal Writing; *Science Education; *Student Attitudes; Student Interests; Student Motivation
IDENTIFIERS Alabama; *Science Achievement

ABSTRACT

This study examined several aspects of elementary science students' achievement, attitudes, and journal writing in conjunction with an Alabama Hands-on Activity Science Program (HASP) grant utilizing the Full Option Science System (FOSS) kit. The sample of 56 fourth grade students in two classes was administered a 15-item pretest and post-test. During the four weeks of the study, students were requested to reflect upon the instruction through journal writing. Results from the data analysis using a t-test indicated a significant difference in student achievement on the pre- and post-test scores. These results suggest that the increase in post-test scores may be attributed to incorporating the FOSS kit into science instruction. The results of the attitude survey did not support using science manipulatives as a means of increasing positive responses to science being a favorite subject, interest in reading about science, science being seen as fun, looking forward to science class, interest in science group activities, interest in science careers, and interest in journal writing. A qualitative content analysis of the journals revealed that both the quality and quantity of the reflective writing fluctuated appreciably from the beginning to the end of the study. (Author/WRM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Running head: EFFECTS OF SCIENCE MANIPULATIVES

ED 427 975

Examining the Effects of Science Manipulatives on Achievement, Attitudes, and Journal Writing of Elementary Science Students

L. Frederick

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Lynda R. Frederick

and

Edward L. Shaw, Jr.

College of Education

Department of Curriculum and Instruction

3100 UCOM

The University of South Alabama

Mobile, AL 36688-0002

A paper presented at the annual meeting of the

Mid-South Educational Research Association, New Orleans, LA, November 4-6, 1998.

BEST COPY AVAILABLE

ED427975

Abstract

This study examined several aspects of elementary science students' achievement, attitudes, and journal writing in conjunction with an Alabama Hands-on Activity Science Program (HASP) grant utilizing the Full Option Science System (FOSS) kit. The sample of 56 fourth grade students in two classes were administered at 15 item pretest and post test. During the four weeks of the study students were requested to reflect upon the instruction through journal writing. Results from data analysis using a t-test indicated a significant difference in student achievement on the pre and post test scores. These results suggest the increase in post test scores may be attributed to incorporating the FOSS kit into science instruction. The results of the attitude survey did not support science being their favorite subject, reading about science, science being fun, looking forward to science, science group activities, science careers, and journal writings. A qualitative content analysis of the journals revealed both the quality and quantity of the reflective writing fluctuated appreciably from the beginning to end of the study.

Examining the Effects of Science Manipulatives on Achievement, Attitudes, and Journal Writing of Elementary Science Students

The use of manipulatives and corresponding hands-on/minds-on, developmentally appropriate activities has been advocated since the late 1950's. According to Haury and Rillero (1992), instructional approaches that involve and direct experiences with natural phenomena have become collectively known as hands-on-science. Additionally, Lumpe and Oliver (1991) defined hands-on science as any activity that allows the student to handle, manipulate or observe a scientific process. Bashaun (1994) stated by involving "students in the learning process, they are no longer outsiders of education" (p.6). This connection is vital for the success of science teaching. Elementary science education went through a massive self-evaluation which resulted in a new generation of elementary science curricula such as SCIS, ESS and SAPA. The core of these alphabet curricula was its dedication to active learning. Rutherford and Ahlgren (1990) stated "Young people can learn most readily about things that are tangible and directly accessible to their senses...." (p.186). With these experiences students understand, can reason, and use logic to make generalizations. Some curricula were process skills oriented, some were content oriented, and some were a blend of both. The various elementary science curricula had little impact on how science was taught in many elementary schools. However, the direction of the development of future curricula was greatly affected.

During the late 1980's and early 1990's a resurgence in the development of elementary science curricula emphasizing the use of hands-on/minds-on, developmentally appropriate activities occurred. Schmieder and Michael-Dyer (1991) found that most national studies concerning teaching and learning in schools indicated that more active learning for students with

more hands-on, direct opportunities to make meaning was needed. Research on the use of hands-on science teaching technique has indicated a positive effect upon achievement (Mattheis & Nakayama, 1988; Brooks, 1988; Saunders & Shepardson, 1984; Bredderman, 1982). The new curricula combine process skills and content but have also added problem solving/decision making skills. Research from the field of educational psychology, science disciplines, input from inservice teachers, new documents such as Benchmarks for Science Literacy (1993), and Science for All Americans (1990), are in accord with the National Science Education Standards (1996) which states, "The new vision includes the 'process of science' and requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science" (p. 105). Although new standards and curricula have been developed, some teachers remained reluctant to use science manipulatives. Shaw and Hatfield (1997) found that elementary teachers on average use manipulatives approximately one day per week and that the use of manipulatives was about the same in all elementary grades. Kloosterman and Harty (1987) found manipulative use greater in grades three through five than kindergarten through second.

According to National Science Education Standards (1996), "Scientific literacy has different degrees and forms; it expands and deepens over a lifetime, not just during the years in school. But the attitudes and values established toward science in the early years will shape a person's development of scientific literacy as an adult" (p. 22). Therefore the development of hands-on/minds-on activities had as its purpose the enhancement and perpetuation of the natural curiosity young children bring to the classroom. Research involving the inclusion of manipulatives in conjunction with science instruction yielded significant increases in the positive attitudes of students toward science instruction and science-oriented careers (Rowland, 1990;

Kyle, Bonnstetter, Gadsden, & Shumansky, 1988; Jaus, 1977; Kyle, Bonnstetter, McCloskey, & Fults, 1985).

Self-assessment and self-reflection are key traits of effective thinkers and problem solvers according to Daniels and Bizar (1998). Therefore, journal writing was included in the study in an effort to triangulate the assessment process, thereby providing a rich picture of student learning including growth, learning problems, and metacognitive reflection and thinking through the use of multiple measures. The use of learning logs or journals allowed the researchers to examine students' achievements from various perspectives. Entries in learning logs or journals enabled students to summarize, record or react to what they have learned. Further, the learning logs provided students with an opportunity to link present knowledge with new knowledge, reflect on what they had learned and open a dialogue with the teacher. Fulwiler (1987) states, "When people write about something, they learn it better" (p. 9). Tomkins (1998) believes students not only think about what they are learning as they write in journals, they are also experimenting with connections between their past experiences and current instruction, and finding deficiencies in what they know and what they need to know.

The journal writing approach utilized in this study was in the form of a learning log which asked students to answer questions at the end of each lesson presented within the instructional unit. Several purposes for using learning logs with informal writing according to Tomkins (1990) and Romano (1987) included preparation for learning, recording observations and experiences, personalization of learning, exploration of different kinds of thinking, independent thought, engagement of the imagination and sharing thoughts with others. Space was also provided on each page for taking notes, making drawings, and constructing graphs. Thus, students were able to personally process information and make ideas their own which were

then reread and studied for the post test. Bromley (1993) states that learning logs facilitate further learning because of the individualized records of student learning they provide.

Methods

John Wright, University of Alabama at Huntsville, created an inquiry-based program developed in response to national standards in 1990 called Hands-on Activity Science Program (HASP), which incorporated exemplary curriculum using modules, Full Option Science System (FOSS), developed and tested nationally with the provision of funding from the National Science Foundation (NSF). The theoretical base for incorporating manipulatives into elementary science instruction is well supported. Therefore, this study was designed to examine several aspects of elementary science students' achievement, attitudes, and journal writing in conjunction with a FOSS kit.

Participants

The sample consisted of 56 fourth-grade students in two separate classes within the same elementary school which was located in a suburban setting. Twenty-eight children were in each of the two classes. The membership of each class included 55% male students and 45% female students of middle to upper class socioeconomic status. The classes were ethnically diverse with populations of approximately 50% white students, 40% African-American students, 5% Asian students and 5% Hispanic students.

All science instruction for each of the two classes was given by the same teacher who was responsible for science education for the fourth and fifth grade students in this particular elementary school. A crucial factor in the selection of this teacher was that she received training in the use of the FOSS Kit during Spring, 1997 and in follow up sessions which were provided in Fall, 1997.

Materials

A Full Option Science System (FOSS) unit on electricity and circuits was presented to both groups by the same teacher. The procedures outlined in the FOSS kit were followed by the teacher. A 15 item test, which was included in the kit, was administered as a pretest and post test. The test consisted of application and knowledge level questions about electricity and circuits. In addition, the researchers developed a 12 item attitude survey that was administered before and after the instruction. The attitude survey included items about the science content presented, instructional strategies, use of the FOSS kit, cooperative learning groups, and journal writing. The subjects responded to the survey via a modified Likert scale. In addition to the test and attitude survey, subjects were requested to reflect upon their participation by writing in journals. The study was conducted over a four week period during the Spring of the 1997 - 98 school year.

Results

Pre and Post Tests

The achievement pre and post test's data were analyzed using SPSS for descriptive statistics and a two-tailed t-test (see Tables 1 and 2). Significant differences occurred between the pre and post tests.

Attitude Survey

Data from the attitude survey were analyzed by calculating percentages of the responses for each item (see Table 3). Results did not support using science manipulatives as a means of increasing favorable responses towards science being their favorite subject, reading about science, science being fun, looking forward to science, science group activities, science careers, and journal writings. Students' responses from the survey indicated that they enjoyed learning

science by themselves, believed electricity was important, learned safety rules for using electricity, and enjoyed studying about electricity.

Content Analysis

As defined by Holsti (1969) a qualitative content analysis is the "drawing of inferences on the basis of appearance or nonappearance of attributes in messages" (p.10). Further, Berelson (1971) stated that in qualitative content analysis the interest of the researcher will "lie less often in the content as such and more often in other areas to which the content is a cue, i.e., which it reflects or expresses or which is latent in the manifest content" (p.124). Qualitative content analysis included not only the subjective opinion of a researcher about individual documents, but an objective description of the content based on the criteria or pre-established categories which depend of the researcher's interest in certain variables as well. Berelson (1952) stated that content analysis is a research technique for the "objective, systematic, and quantitative description of the manifest content of communication"(p.18).

A content analysis of the students' journals revealed both the quality and quantity of the reflective writing fluctuated appreciably over the duration of the instructional unit. Each student was given a journal which contained ten pages with three questions on each page. The questions, "What did I learn?; How can I use what I have learned?; and What I have learned is important because...", were repeated on each page. The questions were placed on the page so that drawings or other types of records could be included. Students had an opportunity to write in their journals following instruction. Neither group wrote on the tenth page and Group II did not write on the seventh page. All other pages were used by both groups. The amount of words per page were counted and averaged for both groups together and individually (see Table 4).

Discussion

Results indicated that elementary students' achievements statistically increased from the pre to the post tests, with the use of the FOSS kit and appropriate instruction. These findings were consistent with previous research (Mattheis & Nakayama, 1988; Brooks, 1988; Saunders & Shepardson, 1984; Bredderman, 1982) and the goals of the new elementary science curricula involving manipulative use with elementary students.

However, the attitudes of the students toward science did not support using science manipulatives as a means of increasing favorable responses towards science being their favorite subject, reading about science, science being fun, looking forward to science, science group activities, science careers, and journal writings. These findings were inconsistent with previous research (Rowland, 1990; Kyle, Bonnstetter, Gadsden, & Shumansky, 1988; Jaus, 1977; Kyle, Bonnstetter, McCloskey, & Fults, 1985) which suggested favorable attitudes towards science instruction and science careers were enhanced when using manipulatives in partnership with classroom instruction. Some possible factors influencing this outcome were as follows: the instructional unit was taught during the fourth quarter of the school year; the instructional unit was taught after the end of the year standardized tests were administered; and the last lesson of the instructional unit was completed on the last day of the school year.

The incorporation of journal writing as a tool for reflection of student learning and participation in the activities yielded negative results also. Both the quality and quantity of the reflective writing varied as each lesson in the unit was presented. The writing on the journal pages ranged from 0 to 176 words per page. On some of the pages students drew diagrams and graphs as well as writing. However, with each progressive lesson, the handwriting became more and more careless, as did the spelling, grammar and punctuation for most of the students. Some

students observed writing conventions and neatness throughout the instructional unit. Also, the answers to the questions became repetitive, with the individual students repeating the same phrase or short sentence on each page of the journal. For example, "I will need this in my future." or "It will be on the test." as a response to "What I have learned today is important because..." .

Another factor that may have contributed to the students' unengaged attitude toward the journals was the assignments that were copied from the board on to the back of the reflective thinking pages. This may have given the students the impression that the journal was more of a notebook to be turned in for a grade than a record of their thinking and learning. The pages that contained the greatest detail and apparent interest in writing and expressing ideas was the page immediately following a lesson on making your own flashlight. The students related very well to that lesson and most drew detailed diagrams of their flashlight plans. Additionally, students wrote explicit plans for using these designs in their lives. These pages yielded the most variation in expression among the students in both groups.

The increase in students' test scores suggests the FOSS kits are effective instructional tools for teaching science. The negative attitudes towards science and journal writings indicated by the responses given on the attitude survey may have implications for science educators at all levels. Longitudinal research needs to be done to determine if using science manipulatives has a negative impact on how students feel about science and journal writing. Therefore, replication of this study, including student interviews, and additional research using the FOSS kit is recommended.

References

American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.

Basham, L.B. (1994). *Active learning and the at-risk students: Cultivating positive attitudes towards science and learning. Unpublished doctoral dissertation.* (ERIC Document Reproduction Service No. ED 374 088).

Berelson, B. (1971). *Content analysis in communication research.* New York: Hafner Publishing.

Berelson, B. (1952). *Content analysis in communication research.* New York: The Free Press of Glencoe.

Bromley, K.B. (1993). *Journaling: Engagements in reading, writing and thinking.* New York:Scholastic.

Daniels, H. & Bizar, M. (1998). *Methods that Matters*. York, Maine: Stenhouse Publishers.

Fulwiler, T. (1987). *The Journal Book*. Portsmouth, NH: Boynton/Cook.

Haury, D.L. & Rillero, P. (1992). *Hands-on Approaches to Science Teaching*. ERIC Clearinghouse for Science, Mathematics, and Environmental Education. The Ohio State University.

Holsti, O. (1969). *Content analysis for the social sciences and humanities*. Reading, MA: Addison-Wesley.

Kloosterman, P. & Harty, H. (1987). *Current Teaching Practices in Science and Mathematics in Indiana Elementary Schools. Final Report.* Indiana Univ., Bloomington. (ERIC Document Reproduction Service No. ED 285 772)

Kyle, W.C., Bonnstetter, R.J., Gadsden, T. Jr. & Shumansky, J.A. (1988). What research says about hands-on science. *Science and Children, 25* (7), 39-40.

Kyle, Jr. W.C., Bonnstetter, R.J., McClosky, J. & Fults, B.A. (1985). What Research Says: Science through discovery: Students love it. *Science and Children, 23* (2), 39-41.

Lumpe, A.T. & Oliver, J.S. (1991). Dimensions of Hands-on Science. *The American Biology Teacher*, 53 (6), 345-348.

Mattheis, F.E. & Nakayama, G. (1988). *Effects of a Laboratory-Centered Inquiry Program on Laboratory Skills, Science Process Skills, and Understanding of Science Knowledge in Middle Grades Students.* (ERIC Document Reproduction Service No. ED 307 148)

National Research Council. (1996). *National Science Education Standards*. Washington, D. C.: National Academy Press.

Romano, T. (1987). *Clearing the way: Working with teenage writers*. Portsmouth, NH: Heinemann.

Rowland, P.M. (1990). *Using science activities to internalize locus of control and influence attitudes towards science*. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Atlanta, GA. (ERIC Document Reproduction Service No. ED 325 333)

Rutherford, F. J. & Ahlgren, A. (1990). *Science for All Americans*. New York: Oxford University Press.

Saunders, W.L. & Shepardson, D. (1984). *A comparison of concrete and formal science instruction upon science achievement and reasoning ability of sixth grade students*. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, LA. (ERIC Document Reproduction Service No. ED 244 797)

Schmieder, A.A. & Michael-Dyer, G. (1991). *State of the scene of science education in the nation*. Paper presented at the Public Health Service National Conference, Washington D.C.

Shaw, E.L. & Hatfield, M. (1997). *Manipulatives in the elementary science classroom*. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Chicago, IL.

SPSS. (1998). *Statistical Package for the Social Sciences*. Chicago, IL: SPSS, Inc.

Tompkins, G. E. (1998). *Language Arts Content and Teaching Strategies*. Columbus, Ohio: Merrill.

Tompkins, G.E. (1990). *Teaching writing: Balancing process and product*. Columbus, OH: Merrill.

Table 1

Descriptive Statistics of Pre and Post Tests

Descriptors	Pretest	Postest
Sample size	56	56
Mean*	12.8	34.5
Standard deviation	4.73	6.08
Range		

*Out of a possible 40 points

Table 2

T-test for Pre and Post Tests

	Pre-Post Paired Differences
Mean	-21.71
Standard deviation	5.96
Standard error of mean	.86
T-test	-25.23
Degrees of freedom	55
Significance (Two-tailed)	.000

Table 3

Results in Percentages of the Science Attitude Survey

Items		Yes	Don't Know	No
1. Science is my favorite subject.	Pre*	46	33	17
	Post*	27	27	40
2. My grades in science are good.	Pre	48	40	8
	Post	65	19	0
3. Reading about science is easy for me.	Pre	56	17	25
	Post	25	27	42
4. Science is fun because we get to do fun things.	Pre	92	2	2
	Post	85	8	0
5. I look forward to science class.	Pre	71	13	10
	Post	62	21	10
6. I enjoy learning science by myself.	Pre	17	8	71
	Post	21	17	56
7. I enjoy learning science with a group.	Pre	79	6	8
	Post	73	6	13
8. I would like to have a career that uses science everyday.	Pre	31	46	19
	Post	31	29	33
9. I believe electricity is important.	Pre	81	4	0
	Post	88	2	4
10. I know safety rules when using electricity.	Pre	85	8	2
	Post	92	2	0
11. I enjoy studying about electricity.	Pre	44	31	10
	Post	48	25	0
12. I enjoy journal writing.	Pre	52	15	29
	Post	21	29	44

*Out of 100% Sample size = 56

Table 4

Vertical numbers indicate average words per page: horizontal numbers indicate the individual page number.